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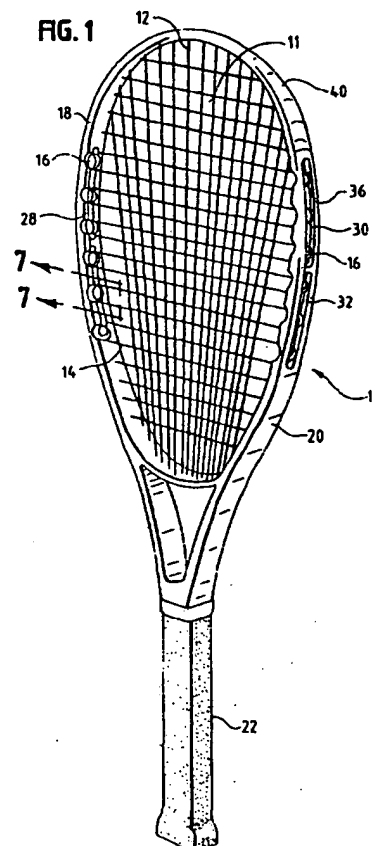
(71) Applicants:
• WILSON SPORTING GOODS COMPANY
Chicago, Illinois 60631-3584 (US)
• Topkey Corporation
Industrial Park Taichung (TW)

(72) Inventors:
• Shen, Walter W. C.
Taichung City (TW)
• Cheng, Po-Jen
Oak Brook, Illinois 60523 (US)

(74) Representative:
Ruschke, Hans Edvard, Dipl.-Ing. et al
Ruschke Hartmann Becker
Pienzenauerstrasse 2
81679 München (DE)

(54) **Racket having bearings in frame for facilitating movement of racket strings outside plane of string bed**

(57) A game racket has bearing members in the head portion of the frame, and the inner wall of the frame is open in the vicinity of the bearing members so as not to obstruct movement of the racket strings in a direction outside the plane of the string bed. The bearing members, which may be in the form of rollers each having a radius of curvature significantly greater than the racket string diameter, facilitate both pivoting and shifting of the portion of racket string looped around the bearing members in response to contact of the string bed with a ball. This ability for increased string movability outside the plane of the string bed lessens shock.



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Description

BACKGROUND

Field of the Invention

[0001] This invention relates generally to rackets for such games as tennis, racquetball, squash, and other racket sports, and more specifically, to rackets adapted to allow for movement of the racket strings in directions outside the plane defined by the string bed.

Description of the Prior Art

[0002] The use of rollers in racket frames for tennis and other racket sports dates back to the late nineteenth century. For example, Richardson, U.S. Patent No. 240,183, issued in 1881, showed rollers provided within the frame of a tennis racket to provide the racket with an adjustable tensioning mechanism. Through the years, there have been several other patents showing the use of rollers in racket frames, such as Goerke, U.S. Patent No. 2,206,548, Aubert, U.S. Patent No. 2,145,785, Reedhead, et al., U.S. Patent Nos. 4,057,249 and 4,203,597, Game, U.S. Patent No. 4,765,621, and Marrello, U.S. Patent No. 5,054,779. Most all of these patents, like the early Richardson 240,183 patent, describe the use of rollers within the racket frame as part of an integral player-adjustable tensioning mechanism.

[0003] While rollers have been used in racket frames for over a century, their use has thus far never permitted string movement in any direction outside the plane of the string bed. The string bed, defined by the interwoven pattern of racket strings, is intended to have some capacity for deflection when it contacts a ball. At the intersection of the inside surface of the racket frame and each segment of racket string in many conventional rackets, the racket string is limited in its range of movement. This can be appreciated with reference to the Marrello 5,054,779 patent, wherein each string segment extends through a passage in the inner wall of the racket frame. Upon deflection of the string bed, the portion of each string segment within the inner and outer walls of the frame is constrained by the portion of the inner wall surrounding the passage (also known as string hole), from pivoting or shifting in any direction other than within the plane of the undisturbed or resting string bed. The plane of the string bed while the string bed is at rest is referred to herein simply as the plane of the string bed. In other words, the exposed portions of the string segments are only permitted to bend from the inner wall of a conventional racket frame, even when such frame includes rollers.

[0004] A further restriction on string movement in conventional rackets provided with rollers is from the shape of the rollers themselves, due to the fact that the grooved portion of the roller that receives the string is generally

just large enough to accommodate the string diameter. As a result, the looped portion of racket string that extends about the roller is tightly constrained by the groove of the roller in which the racket string is seated, and while the string segments may become tighter in response to deflection of the string bed and the roller may rotate to adjust the tension of the racket strings, there is no movement of the strings outside of the plane of the string bed.

[0005] In order to achieve greater flexibility of the string bed, Severa et al., U.S. Patent No. 6,050,909, assigned to Wilson Sporting Goods Co. (the assignee of the present invention), discloses the use of elongated slots oriented perpendicular to the string bed in the inner wall of the side portions of the head of a racket frame.

These elongated slots allow for racquet string deflection, or string bending, from at least the inner ends of short grommet tubes to the narrow ends of the elongated slot. Each of the short grommet tubes extends from a grommet strip on the outside wall of the racket frame, through a hole in the outside wall, and terminates at a point just inwardly of the outside wall of the racket frame. Such deflection or bending of racket string is described herein as pivoting of the string segments. Pivoting of the string segments is advantageous because it results in such benefits as sustained string contact with a ball, increased racket power, and greater shock absorption.

[0006] Another use of roller technology in rackets is in Guthke, U.S. Patent No. 4,441,712, in which rollers or round bearing surfaces are provided within the inner and outer walls of the racket frame, or in alternate embodiments, are provided in tumblers positioned inwardly of the inner wall of the racket frame. While one of the purposes of rotatable elements in the Guthke, 4,441,712 patent is to locally control string tension, rotatable elements are also used in combination with connecting elements to facilitate pivoting of pairs of string segments outside the plane of the string bed. By doing so, the edge region where the string segments typically contact the racket frame is adapted so that contact with the ball in the vicinity of the edge region causes a more symmetrical deflection of the string bed than in conventional rackets.

[0007] Given the advantages attained by providing racket frames that allow for pivoting of the racket string segments outside of the plane of the string bed, it would be desirable for a game racket to facilitate even greater movement of the string segments outside of the plane of the string bed.

SUMMARY OF THE INVENTION

[0008] The present invention combines the benefits of the use of rollers in racket frames with the benefits of string segments that are able to move, when the string bed comes in contact with a ball, in directions outside of the plane of the string bed. The racket frame of the present invention provides rollers or similar bearing surfaces within the racket frame, but not in such a way that

restricts displacement of the looped portions of the racket strings which contact the bearing surfaces. Instead, the string bed is mounted on the frame in such a manner that the string segments in several positions around the head of the frame are able to pivot and, once the coefficient of static friction is overcome, shift in a direction generally perpendicular to the plane of the string bed.

[0009] Advantageously, the agility of a string bed having string segments that can both pivot and shift outside of the plane of the string bed improves the shock absorbing characteristics of the racket. It also results in a racket having a livelier feel for the player. In the most preferred embodiment, roller members are pivotally mounted within the frame of the racket, in the plane of the string bed. Elongated slots in at least the inner wall of the racket frame provide unfettered interaction of the racket string and the roller members.

[0010] Each of the roller members has a string-receiving groove with both a width and a radius of curvature much greater than the string diameter, such that the portion of the racket string looped around the roller member, although tightened so as to be biased toward the center of the groove of the roller member, has the ability to pivot and shift outwardly along the width of the roller member, i.e. in a direction outside the plane of the string bed.

[0011] Another advantage of the present invention is that the pivoting and shifting of the racket string segments both occur at points outwardly of the inner wall of the racket frame. This feature results in a more symmetrical deflection of strings upon ball impact in the edge region of the string bed, i.e. in the area of the string bed nearest the inner wall of the racket frame, without reducing the playable area of the string bed and without increasing the overall size of the racket head. The roller members may be provided entirely within the frame so as to be hidden from view, or extend inwardly and/or outwardly of the frame. Even where the roller members are sized to fit entirely within the frame, a particularly preferred embodiment includes depressions or dimples along the inner wall of the frame in the vicinity of the roller members so as to at least partially expose the roller members for aesthetic purposes. Such dimples also serve to provide greater access to the rollers for both the technician stringing the racket, as well as the player.

[0012] In some alternate embodiments, the roller has a flat outer wall, with or without a rim, allowing for maximum shifting of the string bed. In other embodiments, stationary pins positioned perpendicular to the string bed are substituted for the roller members. These pins may take the form of cylindrical posts, or alternatively, square or rectangular posts each having a concave arch wall member or semi-cylindrical wall member provided opposite the innermost side of the post. Such posts achieve many of the same benefits of the roller members, with the exception of their ability to rotate to compensate for changes in the racket string tension.

[0013] The manner in which these and other aspects and advantages of the present invention are accom-

plished are described in the following detailed description of the preferred embodiment and the drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0014]

FIG. 1 is a rear perspective view of a game racket of the present invention;

FIG. 2 is a front plan view of the racket shown in FIG. 1;

FIG. 3 is a top plan view of the racket shown in FIG. 2;

FIG. 4 is a left side view of the racket shown in FIG. 2;

FIG. 5 is a right side view of the racket shown in FIG. 2;

FIG. 6 is a bottom plan view of the racket shown in FIG. 2;

FIG. 7 is a cross-sectional and perspective view, taken along lines 7-7 of FIG. 1, showing one type of bearing in a racket of the present invention, in the form of a rimmed roller bearing;

FIG. 8 is a cross-sectional view of the bearing shown in FIG. 7, with the frame of the racket head partially broken away;

FIG. 9 is a cross-sectional view, similar to that of FIG. 8, but showing a first alternate type of bearing, in the form of a rimmed roller bearing having an effective bearing surface of constant diameter;

FIG. 10 is a cross-sectional view, similar to that of FIG. 8, but showing a second alternate type of bearing, in the form of a rimless roller bearing having a radiused effective bearing surface;

FIG. 11 is a cross-sectional view similar to that of FIG. 7, with one of the sidewalls of the elongated slot in the head of the racket frame removed, and showing a third alternate type of bearing, in the form of a stationary rod having a tapered effective bearing surface of a generally hourglass shape;

FIG. 12 is a cross-sectional view similar to that of FIG. 11, showing a fourth alternate type of bearing in the form of a stationary rod having an untapered effective bearing surface, with the racket string removed;

FIG. 13 is an enlarged perspective cross-sectional view showing the bearing surface of FIG. 12, with the racket string looped around the bearing surface;

FIG. 14 is a cross-sectional view, similar to that of FIG. 8, rotated 90°, showing a fifth alternate type of bearing in the form of a stationary rod having a cylindrical profile;

FIG. 15 is a cross-sectional view taken along lines 15-15 of FIG. 14;

FIG. 16 is a cross-sectional view, similar to that of FIG. 9, rotated 90°, showing a sixth alternate type of bearing in the form of a rimless roller bearing hav-

ing an effective bearing surface of constant diameter;

FIG. 17 is a cross-sectional view taken along lines 17-17 of FIG. 2;

FIG. 18 is a cross-sectional view, similar to that of FIG. 17, showing the racket strings pivoting on the bearing member, outside the plane of the string bed, in response to the racket contacting a ball;

FIG. 19 is a cross-sectional view, similar to that of FIG. 15, showing the racket strings shifting away from the plane of the string bed and showing rotation of the roller bearings;

FIG. 20 is a rear perspective view of a racket of the present invention, contacting a ball;

FIG. 21 is a cross-sectional view taken along lines 21-21 of FIG. 20; and

FIG. 22 is a cross-sectional view similar to that of FIG. 21, immediately after the ball loses contact with the racket strings, showing the racket strings returned to their original position within the plane of the string bed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] The racket 10 of the present invention is suitable for various racket sports, such as tennis, racquetball, squash, or the like, because the racket 10 can be made of various sizes while retaining its advantages over conventional rackets. The racket 10 includes one or more bearing means that facilitate movement of racket strings in directions outside the plane of the string bed 11. The plane of the string bed 11, as used in the present disclosure, refers to that plane defined by the string bed, composed of all the generally vertically, i.e., longitudinally, oriented racket strings, referred to in the art as main strings 12, and the interwoven generally horizontally oriented racket strings, referred to in the art as cross strings 14, while such main strings 12 and cross strings 14 are at rest.

[0016] One preferred form of the bearing means in the present invention is that of roller members 16 provided in the frame 18 of the head 20 of the racket 10. The racket 10 also has a handle 22. The head 20 of the frame 18 has a first side 24 and a second side 26. The head 20 of the frame 18 has an inside wall 28 and an outside wall 30. As best shown in FIGS. 1, 4 and 5, the first side 24 and the second side 26 include elongated slots 32 therein. The elongated slots 32 include first and second sidewalls 34, 36, which lie parallel to the plane of the string bed 11.

[0017] Preferably, the roller 16 is mounted on a pin 38, which extends through a central axis of the roller 16. The pin 38 can be integral with the sidewalls 34, 36 of the elongated slots 32, or be received in small depressions or pin-receiving apertures 39, depending on the manner in which the racket 10 is manufactured. So long as the roller 16 has at least a small clearance between

an opening in its central axis and an outer diameter of the pin 38, which is the case in the preferred embodiment of the present invention, each of the rollers 16 is able to rotate about its respective pin 38.

[0018] The elongated slots 32 extend at least through, i.e. are open at, the inside wall 28 of the head 20 of the frame 18. While in the embodiments shown the elongated slots 32 are also open at the outside wall 30 of the head 20, depending on the diameter of the roller 16, or similar dimension of any other form of bearing means utilized, the elongated slots 32 may be closed at the outside wall 30. Furthermore, even in the event the elongated slots 32 are open at the outside wall 30, such open regions of the outside wall 30 can be covered with bumper tape or with a bumper strip 40, in order to protect the rollers 16 from debris and obscure the rollers 16 from view, at least from the direction of the outside wall 30 of the head 20.

[0019] By having the elongated slots 32 open at the inside wall 28, the sidewalls 34 and 36 advantageously provide first and second boundaries that define a maximum range of displacement for a half-loop 42 of racket string in a direction outside the plane of the string bed 11. The half-loop 42 of racket string is that portion of the racket string wrapped about an outer side of the roller 16, or other bearing means.

[0020] Upon contact with a ball 43, a conventional string bed has a tendency to produce shock that is often translated to a player's hands and arms through the handle 22. This is due to the tension in the racket strings. Recent improvements in racket technology has shown that by increasing the ability of the racket strings to bend in a direction perpendicular to the plane of the string bed 11, the ball 43 can stay in contact with the racket strings for a longer duration of time, resulting in improved control over the ball 43, among other benefits. This bending of the racket strings, referred to herein as pivoting, has been the only manner of racket string movement in directions outside the plane of the string bed 11. Movement of racket strings within the plane of the string bed 11 has long been performed with the use of rollers, in order to adjust the tension of the strings.

[0021] The present invention, when rotatable rollers 16 are used as the bearing means for the half-loops 42 of racket string, still allows for this movement in the plane of the string bed 11. Additionally, by providing the roller 16 with an effective bearing surface 44 having a radius of curvature greater than the racket string diameter, the pair of racket string segments joined by each half-loop 42 are able to pivot, as shown in FIG. 18, from 0°, which is in the plane of the string bed 11, to an angle α . Depending on the geometry of the bearing means, for example the roller 16, either the rims 46 of the roller 16 or the sidewalls 34, 36 of the elongated slot 32 may limit the maximum degree of pivoting. When the string segments pivot to their maximum amplitude α , the rollers 16 will rotate to adjust the tension in the string segments, and the string segments will advantageously

shift in a direction generally perpendicular to the plane of the string bed 11, as shown in FIG. 19. In FIG. 19, the racket string, which has already pivoted to its maximum angle α , shifts from position a to position b.

[0022] It is understood that when the string segments reach their maximum pivot, the coefficient of static friction between the half-loop 42 and the effective bearing surface of the bearing means, such as the roller 16, is overcome, which enables the half-loop 42 to shift from position a to position b.

[0023] Because the rollers 16, in this embodiment, have the radiused effective bearing surface 44, the string segments would tend to tighten while shifting from position a to position b, by virtue of the fact that the half-loop of string 42 is being stretched around a wider portion of the roller 16, closer to one of the rims 46 of the roller 16. In order to compensate, the rollers rotate, as indicated by the curved arrows in FIG. 19.

[0024] Upon reaching maximum pivot and after shifting from position a (in the plane of the string bed 11) to position b, the racket string segments have a tendency to reverse their movement, and return to their original position in the plane of the string bed 11 as the ball 43 loses contact with the racket strings, as shown in FIG. 22.

[0025] As shown in FIGS. 7-16, the bearing means can take numerous forms and still achieve the benefits of the present invention. By way of example, the bearing means can be in the form of a rimmed roller member 16 having a radiused effective bearing surface, as described above and shown in FIGS. 7 and 8. In a first alternative form, the bearing means can be a rimmed roller member 116 having an effective bearing surface of constant diameter, as in FIG. 9. As used herein, the term effective bearing surface is intended to mean that portion of the bearing member against which the half-loop 42 of the racket string may contact at any given time.

[0026] In a second alternative form, the bearing means can take the form of a rimless roller member 216, as shown in FIG. 10, and having a radiused effective bearing surface. This rimless roller member 216 has the advantage over the rimmed roller member 16 of a somewhat greater unobstructed area within the elongated slot 32 for the racket strings to move outside of the plane of the string bed 11. However, without a rim, it is preferable to have only a very small clearance between the sides of the roller member 216 and the sidewalls 34, 36, to avoid the half-loop 42 of racket string becoming derailed from the roller member 216 and getting stuck between the roller member 216 and one of the sidewalls 34, 36.

[0027] As indicated by the curved arrows in FIGS. 8 and 10, the radiused effective bearing surface biases the racket string segments 14 back toward their original at-rest location, i.e. within the plane of the string bed 11, so that the half-loop 42 of racket string always has a tendency to return to that original location after movement outside the plane of the string bed 11 due to con-

tact with the ball 43.

[0028] The third alternate form of the bearing means is shown in FIG. 11, and is a stationary rod 316 having a tapered effective bearing surface of a generally hour-glass shape. By tapering inwardly at a point intermediate the sidewalls 34, 36, the rod 316 has an effective bearing surface that shares many of the attributes of the radiused roller members 16, 216 discussed above, with the exception that the rod 316 does not rotate.

[0029] A fourth alternate form of the bearing means is shown in FIGS. 12 and 13, which shows a stationary rod 416 with an untapered effective bearing surface. FIGS. 14 and 15 show a fifth alternate form of the bearing means, wherein a stationary rod 516 having a cylindrical shape is used. FIG. 16 shows a final alternate form of the bearing means, although it will be appreciated by those of ordinary skill in the art that many other variations of the bearing means are possible that achieve, and are considered within the scope of, the present invention. In FIG. 16, a rimless roller bearing 616 having an effective bearing surface of constant diameter is provided.

[0030] It will be appreciated by those of ordinary skill in the art that while the preferred embodiments of the present invention discussed herein show the use of bearing means, such as rollers 16, in the sides 28, 30 of the head 20 of the racket frame 10, with only the cross strings 14 being strung around the rollers 16, it is also within the scope of the present invention for the rollers 16, or other bearing means, to be instead, or even additionally, provided in the top and/or yoke portions of the head, such that the main strings 12 would also be able to move outside the plane of the string bed 11. As with the roller member 216 described above, it is preferable to have only a very small clearance between the sides of the roller member 616 and the sidewalls 34, 36, to avoid the half-loop 42 of the cross strings 14 becoming derailed from the roller member 616 and getting stuck between the roller member 616 and one of the sidewalls 34, 36.

[0031] Preferably, each of the roller members 16, 116, 216, and 616 are made of a smooth non-stick material, such as nylon. This also is a favored material because it results in low weight rollers, so as not to dramatically change the weight characteristics of the racket 10. Most preferably, the nylon roller members are vapor coated to give them a more durable appearance.

[0032] While the present invention has been described with respect to certain preferred embodiments thereof, it will be appreciated by those of ordinary skill in the art that variations may be made thereto that are still within the scope of the appended claims.

55 Claims

1. A game racket comprising:
 - a handle portion and a head portion, said

- head portion being defined by a lower end, an upper end, a first side and a second side, each of said first and second side including at least one elongated aperture therein, said elongated aperture having a pair of sidewalls extending in a plane parallel to a generally planar string bed substantially bounded by the head portion, and each of said elongated apertures receiving one or more rollers therein, each of the one or more rollers being supported by a pin extending between the sidewalls of the respective elongated aperture and through a central axis of the roller, said string bed comprising a plurality of generally horizontally oriented string segments and a plurality of generally vertically oriented string segments, one pair of said horizontally oriented string segments being strung in such a manner as to form a half-loop of racket string about one of said rollers, and said roller having a radius of curvature substantially greater than the diameter of said horizontally oriented string segments, facilitating movement of said half-loop of racket string segment in a direction toward one of said sidewalls when said string bed contacts a .
2. The racket of claim 1, each of said rollers being rotatable about said respective pins.
 3. The racket of claim 1, wherein each of said rollers are rimless.
 4. The racket of claim 2, wherein said facilitated movement of said half-loop of racket string segment includes pivoting of said at least one horizontal string segment of said one pair of the horizontally oriented string segments in said direction toward one of the sidewalls.
 5. The racket of claim 4, wherein said facilitated movement of said half-loop of racket string segment further includes shifting of said at least one horizontal string segment of said one pair of the horizontally oriented string segments in said direction toward one of the sidewalls.
 6. The racket of claim 4, wherein said roller rotates about said pin upon said pivoting of at least one horizontal string segment of said one pair of the horizontally oriented string segments in said direction toward one of the sidewalls.
 7. A game racket comprising:
 - a handle portion and a head portion, said head portion being defined by a lower end, an upper end, a first side and a second side, an inner wall and an outer wall, each of said first and second side including at least one elongated aperture therein extending at least through said inner wall, said elongated aperture having a pair of sidewalls extending in a plane parallel to a generally planar string bed substantially bounded by the head portion, and each of said elongated apertures receiving one or more bearing means therein, each of the one or more bearing means extending between the sidewalls of the respective elongated aperture, said string bed comprising a plurality of main string segments and a plurality of cross string segments, one pair of said cross string segments being strung in such a manner as to form a half-loop of racket string about one of said bearing means, and said sidewalls of the elongated opening providing first and second boundaries defining a maximum range of displacement of said cross string segments in the half-loop of racket string in a direction outside the plane of the string bed.
 8. The game racket of claim 7, wherein said bearing means comprises a roller, said roller mounted on a pin extending perpendicularly to said sidewalls and through a central axis of said roller.
 9. The game racket of claim 8, wherein said roller has a radius of curvature substantially greater than a string diameter of said cross string segments.
 10. The game racket of claim 7, wherein said displacement of said cross string segments includes pivoting of at least one of the pair of the cross strings in a direction toward one of said sidewalls.
 11. The game racket of claim 10, wherein said displacement of said cross string segments further includes shifting of the pair of cross strings in the direction toward one of said sidewalls.
 12. The game racket of claim 7, wherein said bearing means comprises a cylindrical post.
 13. The game racket of claim 7, wherein said bearing means comprises a post having an outermost curved surface, said curved surface having its apex adjacent to said outer wall.
 14. The game racket of claim 13, wherein said curved surface of the post tapers inwardly in a generally hourglass shape toward a narrowest portion thereof located between said sidewalls.
 15. The game racket of claim 14, wherein said narrowest portion has a radius of curvature substantially greater than a diameter of said cross string segments.
 16. A game racket comprising:
 - a handle portion and a head portion, said head portion being defined by a lower end, an upper end, a first side and a second side, an inner wall

and an outer wall, a string bed comprising a plurality of generally longitudinally oriented main string segments and a plurality of cross string segments, one pair of said cross string segments being strung in such a manner as to form a half-loop of racket string about a bearing means located outwardly of said inner wall of one of the sides of the head portion, said half-loop of racket string being pivotable in a direction outside the plane of the string bed and further being shiftable outside the plane of the string bed upon contact of said string bed with a ball.

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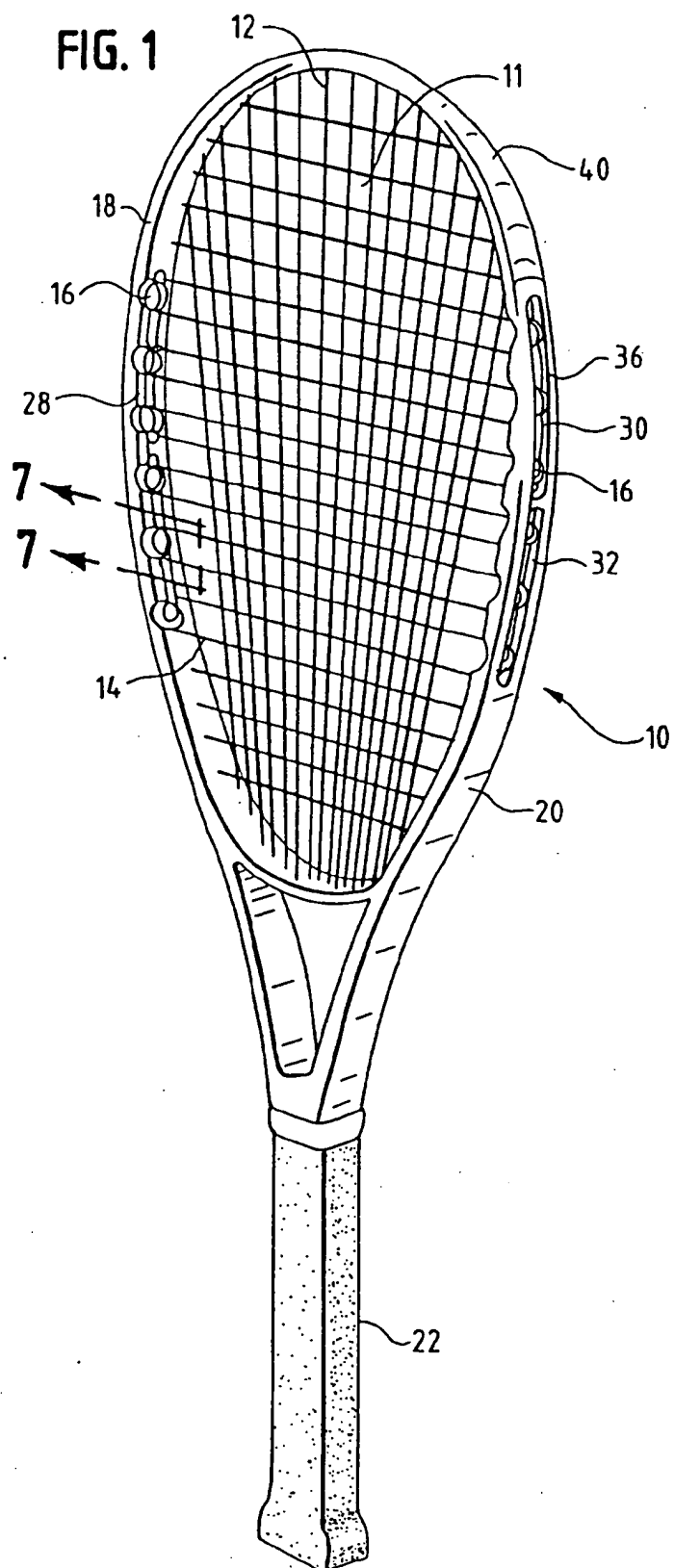


FIG. 3



FIG. 2

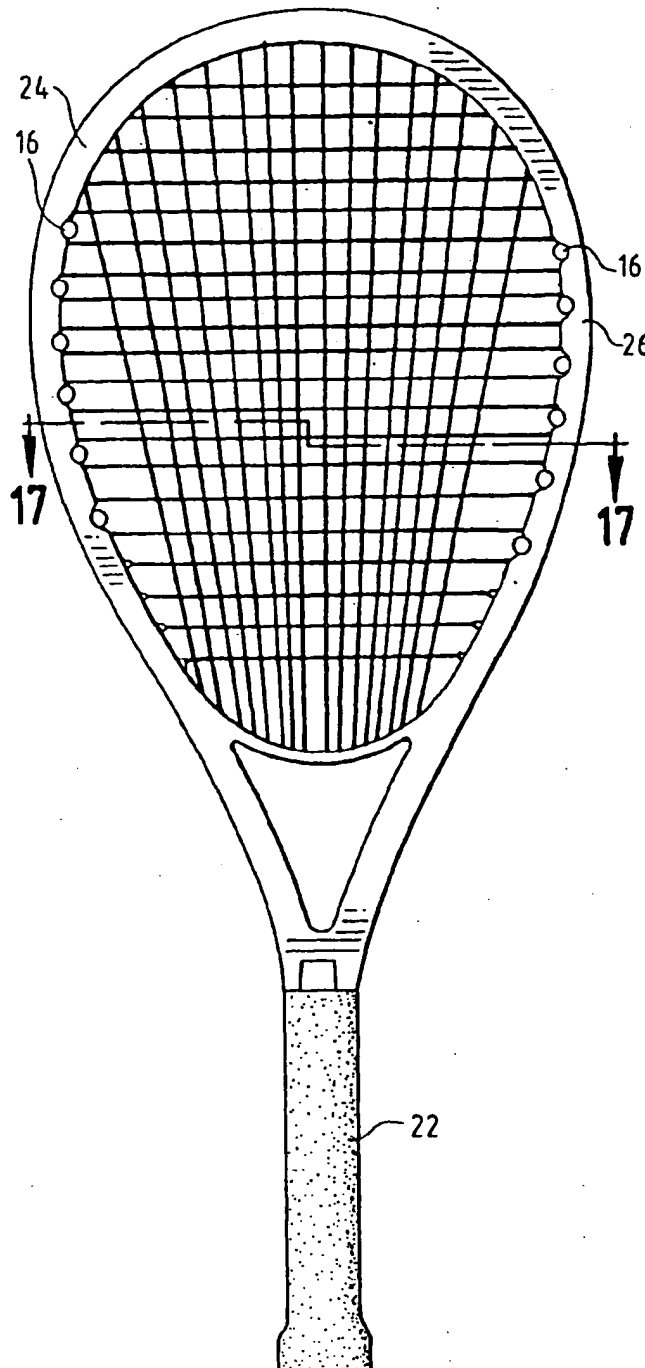


FIG. 4

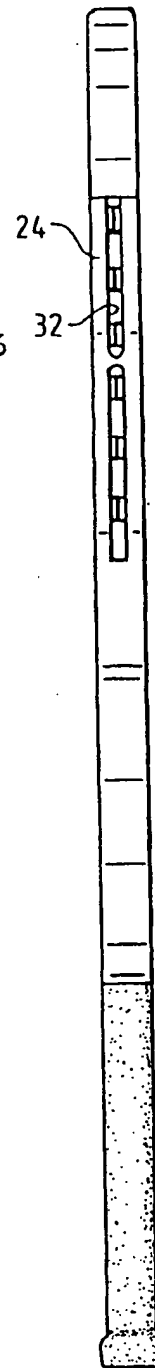


FIG. 5

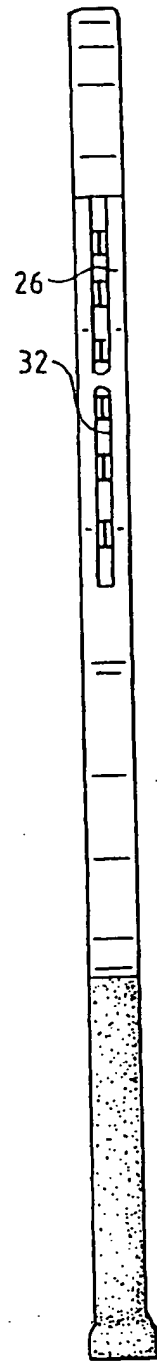


FIG. 6



FIG. 7

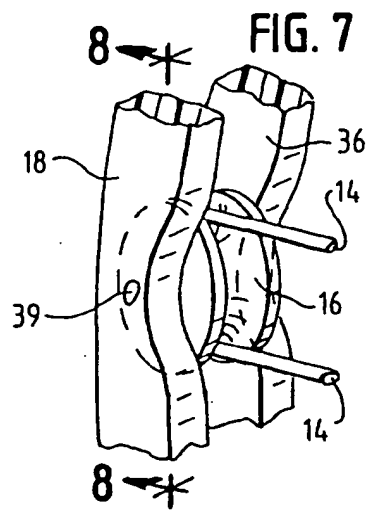


FIG. 8

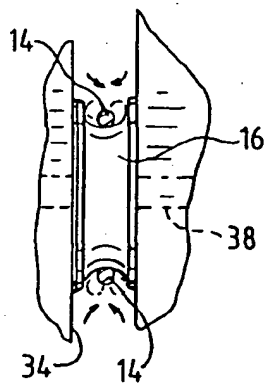


FIG. 9

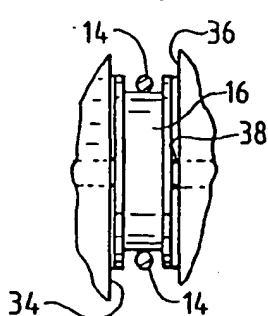


FIG. 10

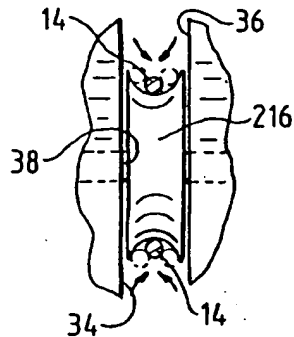


FIG. 11

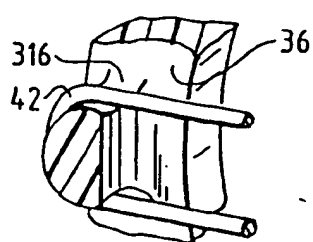


FIG. 12

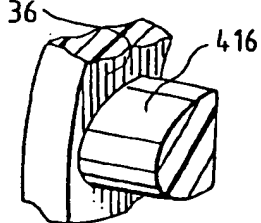


FIG. 13

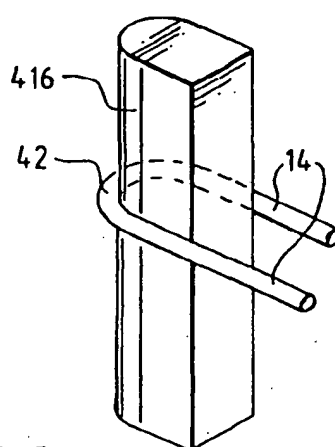


FIG. 14 15 15

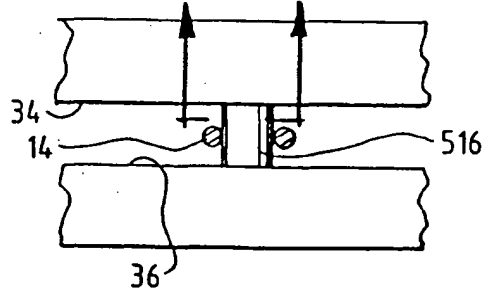
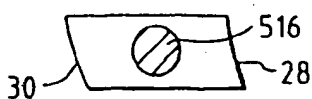
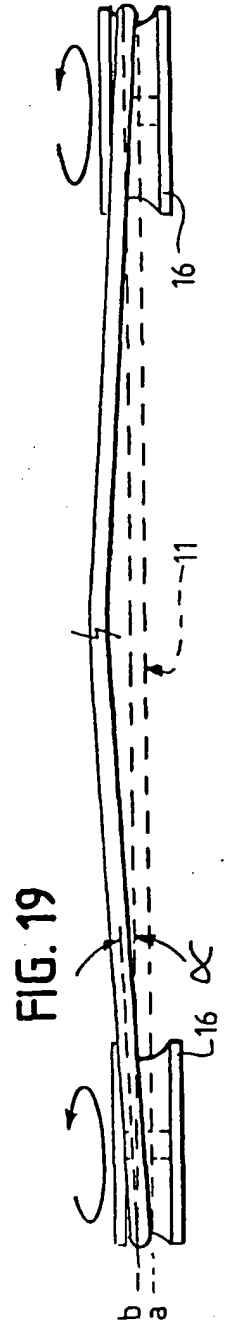
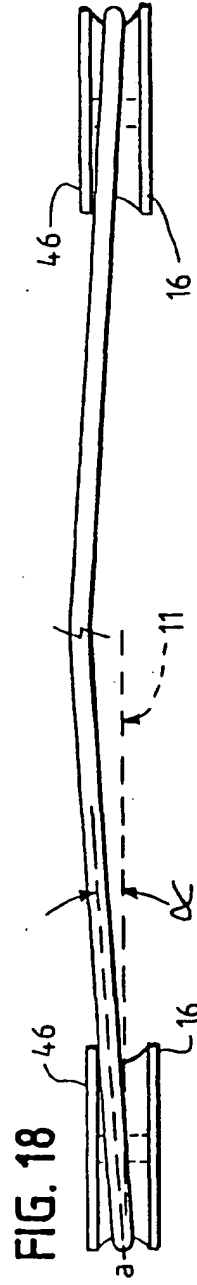
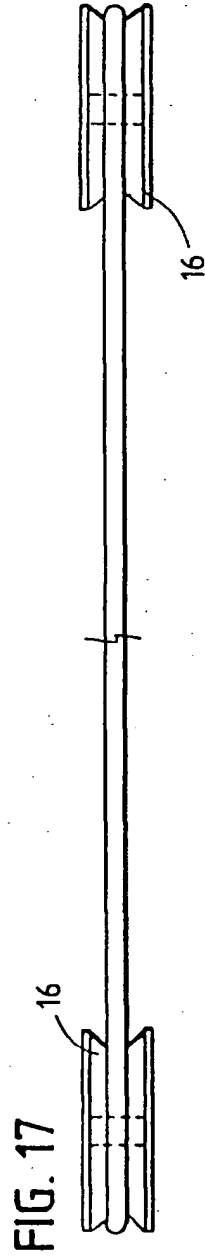
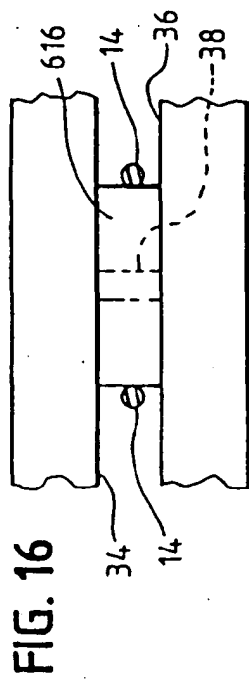
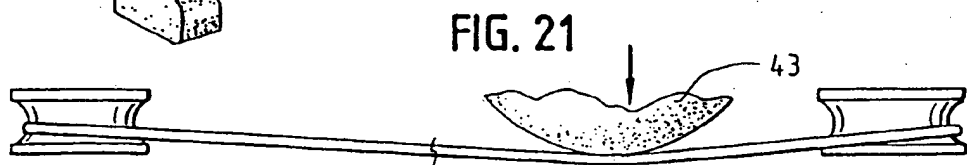
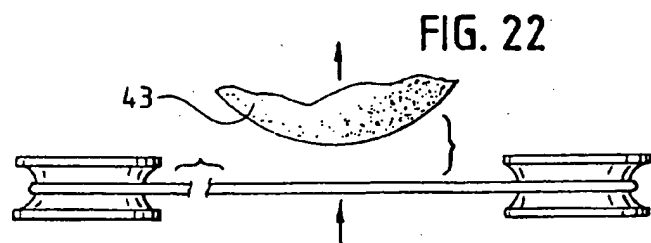
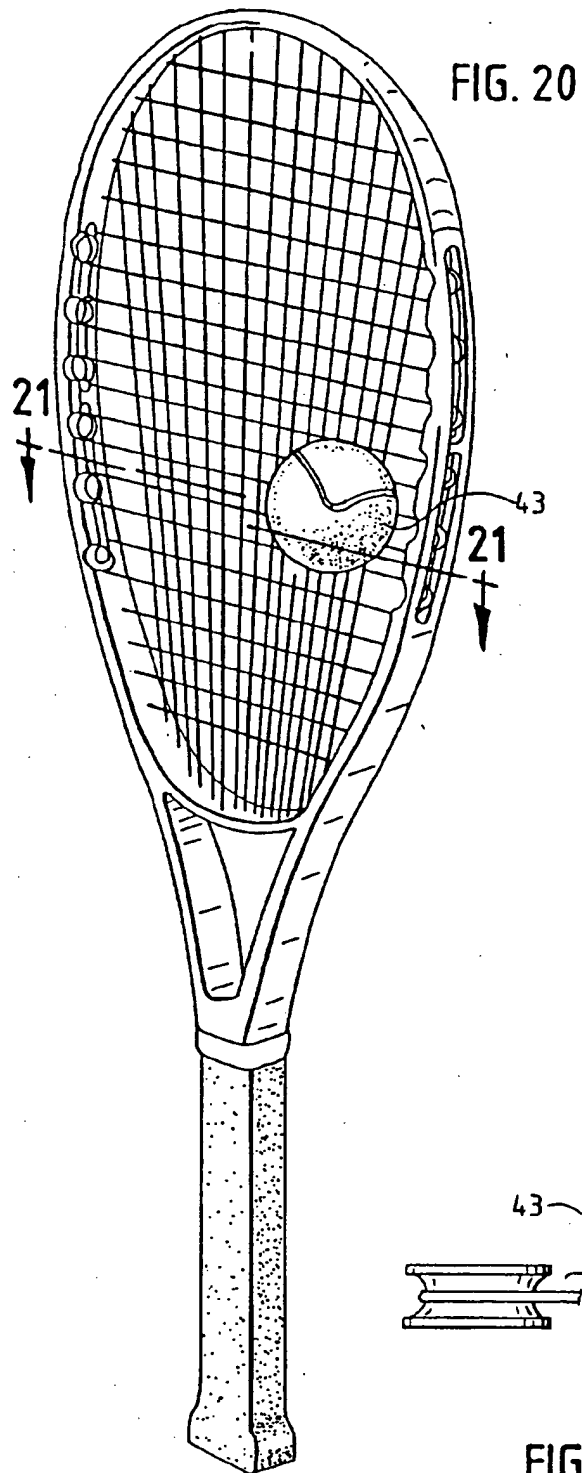
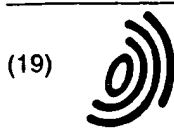


FIG. 15









(19)

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(72) Inventors:
• **Shen, Walter W. C.**
Taichung City (TW)
• **Cheng, Po-Jen**
Oak Brook, Illinois 60523 (US)

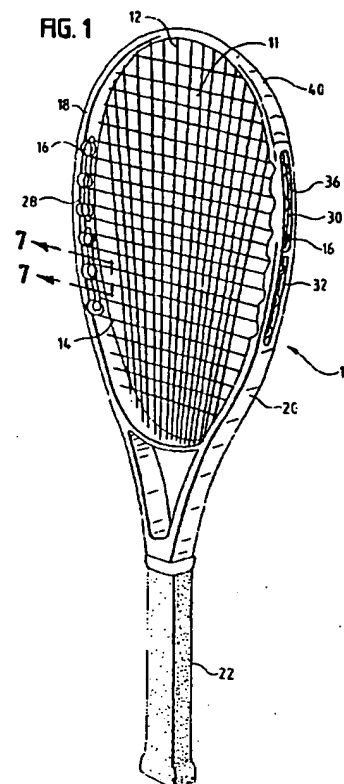
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(74) Representative:
Ruschke, Hans Edvard, Dipl.-Ing. et al
Ruschke Hartmann Becker
Pienzenauerstrasse 2
81679 München (DE)

(71) Applicants:
• **WILSON SPORTING GOODS COMPANY**
Chicago, Illinois 60631-3584 (US)
• **Topkey Corporation**
Industrial Park Taichung (TW)

(54) **Racket having bearings in frame for facilitating movement of racket strings outside plane of string bed**

(57) A game racket (10) has bearing members (16) in the head portion of the frame, and the inner wall of the frame is open in the vicinity of the bearing members so as not to obstruct movement of the racket strings in a direction outside the plane of the string bed (11). The bearing members (16), which may be in the form of rollers each having a radius of curvature significantly greater than the racket string diameter, facilitate both pivoting and shifting of the portion of racket string looped around the bearing members (16) in response to contact of the string bed with a ball. This ability for increased string movability outside the plane of the string bed lessens shock.





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 01 10 7941

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			TECHNICAL FIELDS SEARCHED (In I.C.L.7)
			A63B
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 4 December 2002	Examiner Curzi, D
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	
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